Future Role of Condition Prediction in Reliability and Availability

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Goals

- Increase human reliability
- Predict more
- Create a business decision templates as prognostic advisers.
  - Maximize Reliability ?
  - Maximize Availability ?
  - Maximize Revenue ?

Increase human reliability

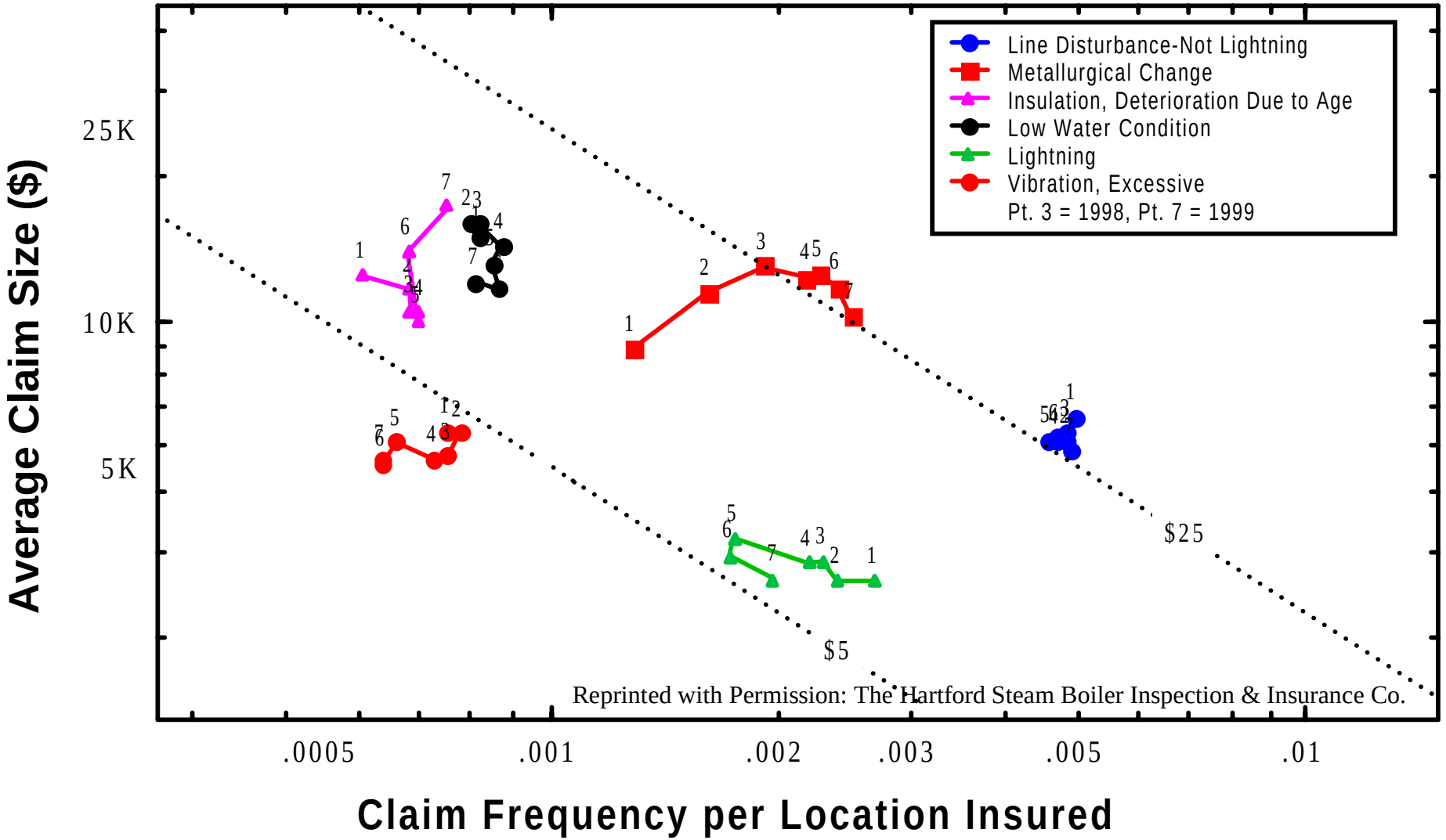
- Reduce human staffing requirements.
- Develop Contributing Causal Factor Taxonomy.
- Develop a consortium to warehouse, administrate and *share* the data.
- Close call reporting system - *Aviation Safety Reporting System (ASRS) NASA - FAA*

Predict more

- Standard definition of “failure” – a recordable event
- Standard definition of “severity” – *total* cost of event
- Nonstationary reliability modeling:
  - Nonhomogeneous processes – failure rate(t)
  - Bayesian with condition data as continuous “update distribution”
- Statistical Trend Analysis as a predictive component
  - Dynamic Statistical Trend and Pattern Analysis

Frequency – Severity Trending

US Commercial Equipment Risk by Cause of Loss



F A I L U R E D A T A C O M P I L A T I O N

Group Definitions

Start Date: 5 - 4 - 1995

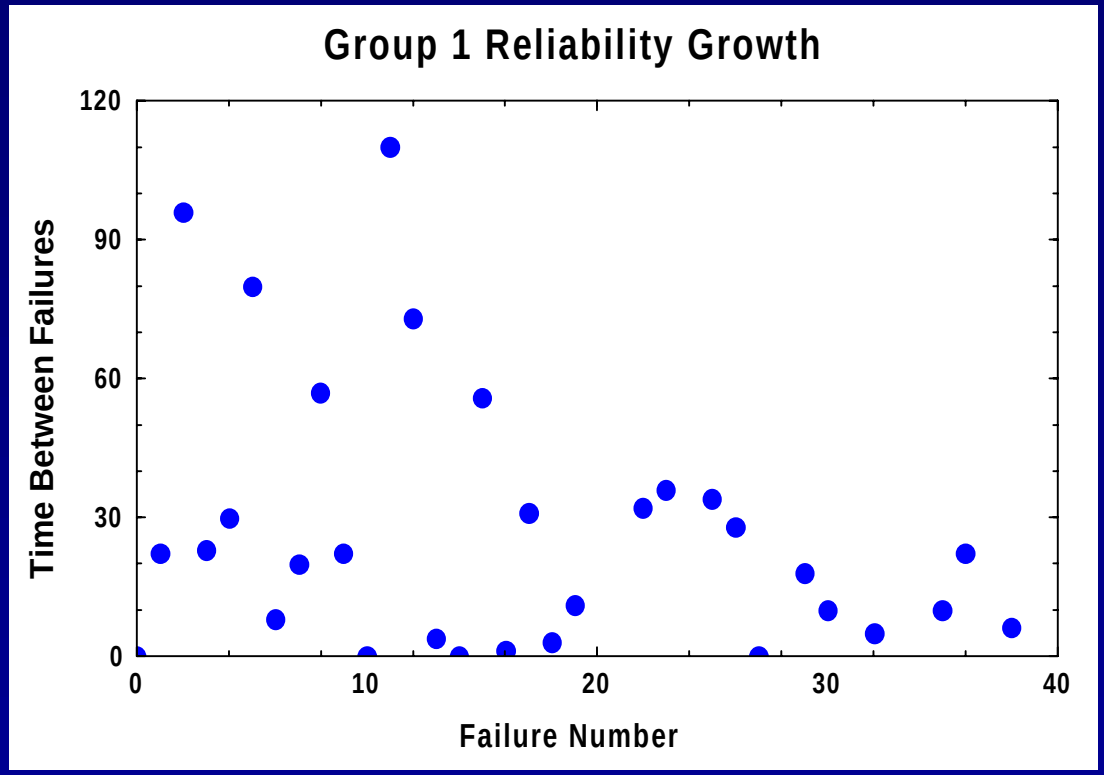
End Date: 1 - 15 - 2002

Group	Failure ID
___	CARRIER
___	CLARK
___	DELAVAL
___	M1965-#4DRMPMP
___	M1965- Bearings
___	M1965-WND-MTR
___	M3816-Bearings
_1_	M3816-Loose-Bolts
_1_	M3817-Vibration
_1_	M3847-Lubrication
_1_	M4068-#6-Bearings
___	M4233- AUX_OIL
___	M5216-#5-Seals
_1_	P3787-3-6-Seals
_1_	P3787-3-6-Vibration

Group	Failure ID
___	P3805-Misc.
___	P3806-Misc.
_1_	P3807-Vibration
___	P4184-Lube-Oil
___	P4195-Aux_Oil
_1_	P5002- Bearings
_1_	P5002-Seals
___	P5922-Loose-Bolts
___	P7233-Bearings
___	Turbine-3760-Vibration
___	Turbine-3808-Vibration
___	Turbine-4144-Bearings
___	Turbine-4671-Bearings
___	Turbine-5921-Lube-Oil

Dynamic Statistical Trend and Pattern Analysis

Class	Failure Mode
5	M3816-Loose-Bolts
1	M3817-Vibration
4	M3847-Lubrication
2	M4068-#6-Bearings
3	P3787-3-6-Seals
1	P3787-3-6-Vibration
1	P3807-Vibration
2	P5002-#6-Bearings
3	P5002-#6-Seals



Laplace:	Deterioration - 95%	
Mil-Hbk-189:	Deterioration - 92%	Predicted Time to Next Failure: 25 days
Rank:	Deterioration - 89%	MTBF: 45 days
Regression:	Deterioration - 90%	

Create business decision templates as prognostic products

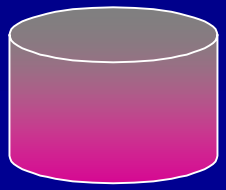
Enter:

Scheduled Maintenance Inspection Cost: $_____

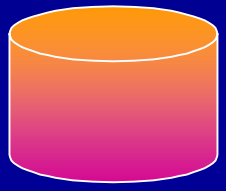
Unscheduled Equipment Repair Cost: $_____

Loss of Productivity Cost due to Failure: $_____

Fixed Cost: $_____

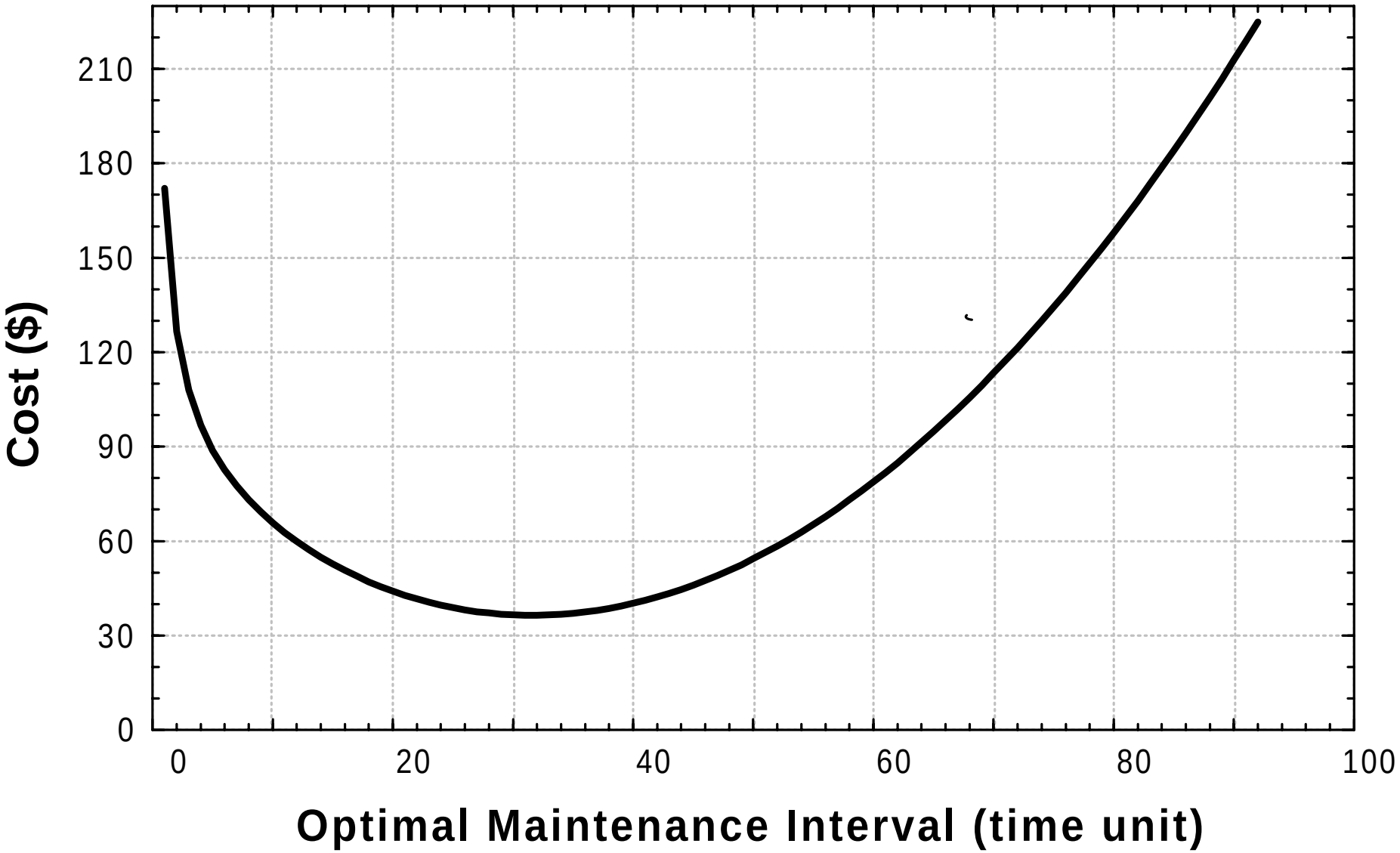


Equipment Categorized "Failure" History



Equipment Categorized Condition Data

Optimal Inspection Time



Reliability, Availability, or *Ri$k*

- Fleet vs. single turbine tradeoffs
- 20% chance of rain?
- LTSAs with fewer words and more coverage
- Condition monitoring use → guarantees
  ……..risk pools & insurance
- The Future: Condition *Prediction ..not monitoring.*